(12) UK Patent Application (19) GB (11) 2 091 882 A

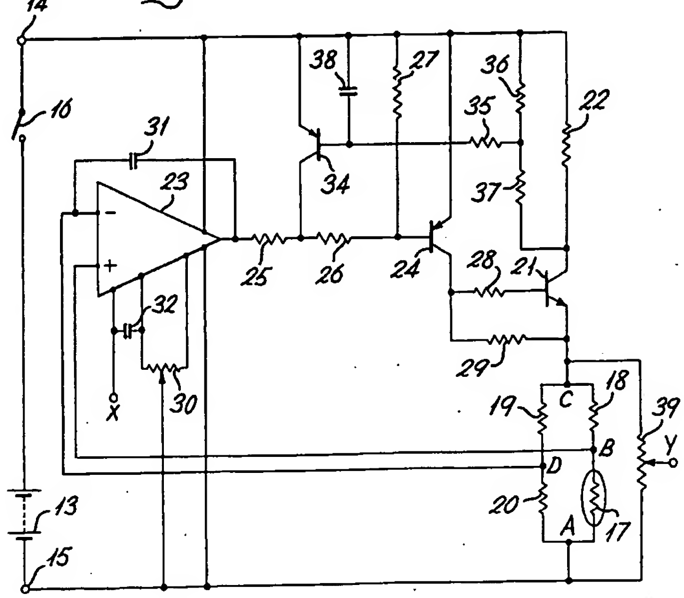
(21) Application No 8201618
(22) Date of filing 20 Jan 1982
(30) Priority data
(31) 8102233
(32) 26 Jan 1981
(33) United Kingdom (GB)
(43) Application published 4 Aug 1982
(51) INT CL[3] G01N 25/30
(52) Domestic classification G1N 1A3B 1A3C1 1D13 1F 3S2 4E 7K ACJ AJA
(56) Documents cited
GB 2059069
GB 1437075
GB 1110778
GB 1094038
EP 0008977A
(58) Field of search G1N

(71) Applicants
National Research Development Corporation,
P.O. Box 236,
Kingsgate House,
66-74 Victoria Street,
London, SW1E 6SL.
(72) Inventors
Ronald Wilson
(74) Agents
Mr. D.H. Bridges,
Patent Department,
National Research Development Corporation,
Kingsgate House,
66-74 Victoria Street,
London, SW1E 6SL.

(54) Electrical catalytic gas detection systems

(57) Intermittent measurements of gas concentration are made using a "pellistor" or like catalytic sensing element while avoiding lengthy heating-up times. The resistor (17) of the element, serving both as heater and thermal sensor, is connected in a bridge network (ABCD) having an associated servo loop which controls current supplied to the network (ABCD) via a transistor (21). An operational amplifier (23) in the loop is switched from a quiescent state, when the network (ABCD) is substantially de-energised, to an active state, when sufficient current is supplied to heat the element to operating temperature, and subsequently back to the quiescent state after a steady state condition is reached wherein the servo loop operates to hold the element at constant temperature; a voltage appearing on an output line (Y) is sampled while that condition applies to provide the measurement. Compensation for ambient temperature variations is effected by means of a simple reference circuit incorporating a semiconductor diode. A system for the controlling the sequential operation of the system is disclosed, Figure 5 (not shown).

Fig. 2



GB 2 091 882 A

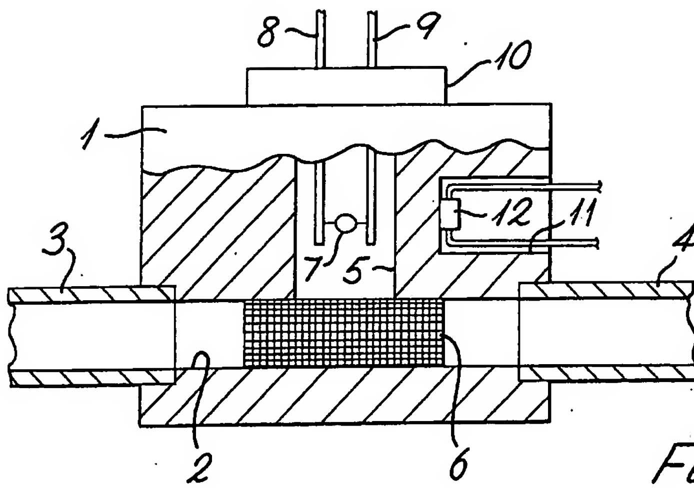
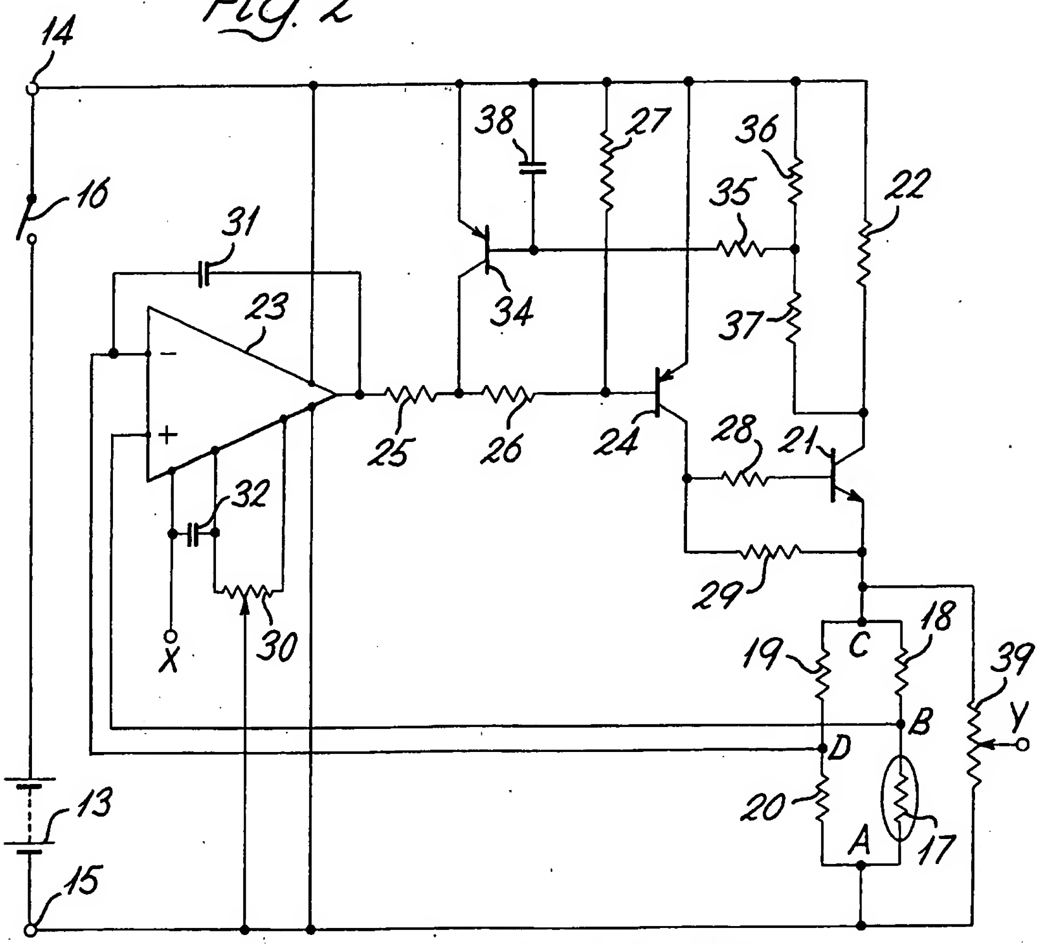


Fig. 1

Fig. 2



BEST AVAILABLE COPY

2091882

2/2

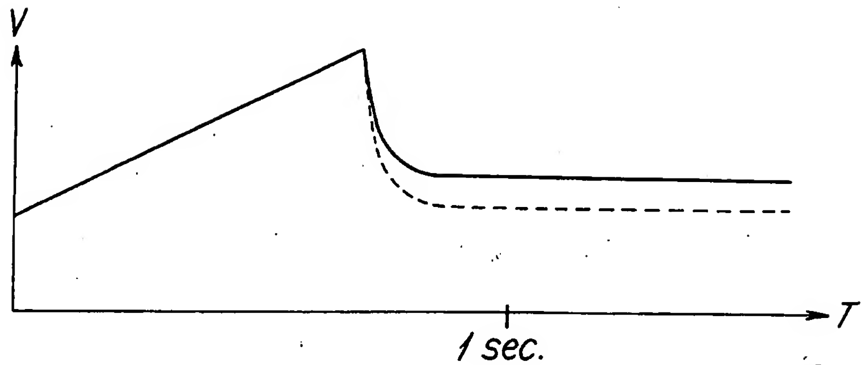


Fig. 3

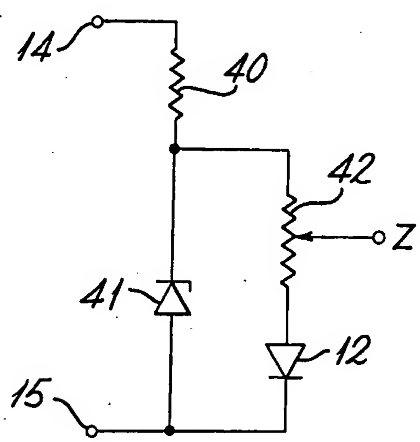


Fig. 4

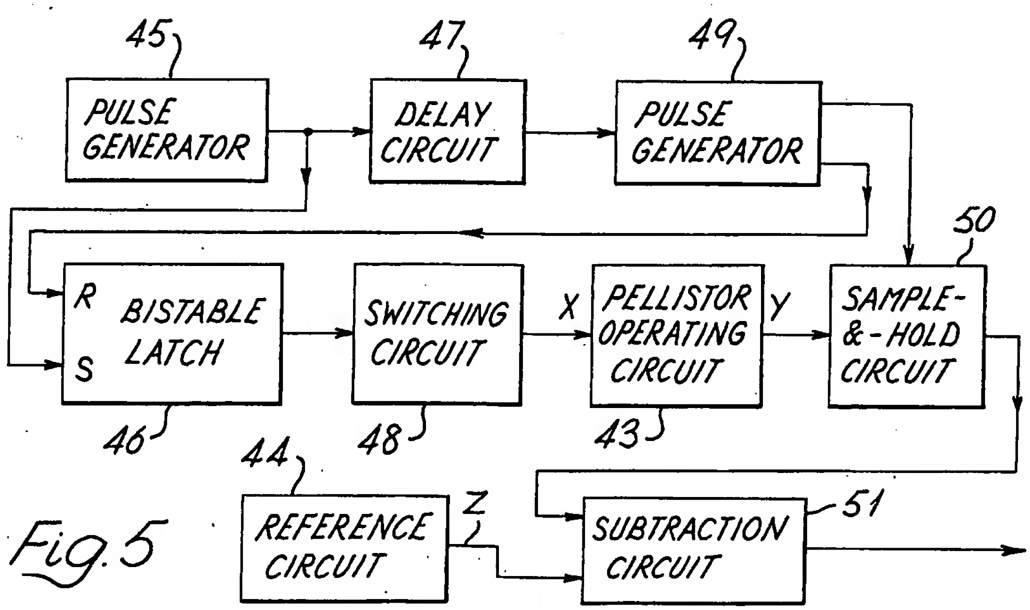


Fig. 5

BEST AVAILABLE COPY

SPECIFICATION

Catalytic gas detection systems

This invention relates to gas detection systems of the kind incorporating a sensing element which embodies a catalyst material exposed for contact with gaseous samples to be tested, the element being at least partly constituted by a thermally sensitive electrical resistor through which current is passed to heat the catalyst material and which also serves as a sensor responsive to the temperature of the catalyst material. One form of sensing element utilised in such systems consists simply of a wire of platinum or a platinum-base alloy, which constitutes both the catalyst material and the thermally sensitive resistor; in an improved form of element, known as a "pellistor" and described for example in British Patent Specification No. 892,530, the catalyst material is constituted by a surface coating or impregnation of a pellet of refractory material within which is embedded a coiled part of a wire which constitutes the resistor.

Gas detection systems of the kind specified are primarily used for detection of combustible gases in oxygen-containing atmospheres, but also have other possible applications. They operate by virtue of the sensing of thermal effects associated with the occurrence on the catalyst material of at least one reaction which is either participated in or influenced by a specific gas to be detected. For this purpose it is usual in such systems for the sensing element resistor to be connected in a resistive bridge network arranged to be supplied with current such that the catalyst material will be heated to a temperature at which the appropriate reaction(s) can occur, there being derived from the network an output voltage whose value is dependent on the relevant thermal effects (and hence on the concentration in a test sample of the gas or gases to be detected). The conventional practice in this respect is to employ a standard Wheatstone bridge arrangement so as to detect directly changes in the resistance of the sensing element resistor caused by the thermal effects to be sensed, i.e. a source of nominally constant voltage is connected between one pair of diagonally opposed terminals of the bridge network and the output voltage is derived from the other pair of terminals of the network; to cater for possible variations in parameters such as the ambient temperature and the source voltage, it is normal with this arrangement to provide a compensating element similar in form to the sensing element but of a non-catalytic nature, the sensing and compensating elements being exposed as far as possible to the same conditions and having their respective resistors connected in adjacent arms of the bridge.

A disadvantage of the standard Wheatstone bridge arrangement is that it is not well adapted for used in cases where it is desired to make only intermittent measurements, under either automatic or manual control. It is obviously desirable in such cases to void unnecessary consumption of power by de-energising the bridge between individual measurements, but the snag then arises that when the bridge is energised with the sensing element initially in a cold state a significant time elapses before the bridge reaches a steady operating condition in which a reliable reading can be obtained; typically this time is of the order of 10 seconds when the sensing element is a pellistor. A further disadvantage of the Wheatstone bridge arrangement using a compensating element is the need to match carefully the sensing and compensating elements used in a specific system.

The present invention is based on the realisation that an improvement in these respects can be achieved if one adopts an alternative to the standard Wheatstone bridge arrangement in which the current supplied to the bridge network is automatically controlled, in response to a feedback signal derived from the network, so that a steady state operation the resistance of the sensing element resistor is maintained substantially constant (at a value corresponding to the desired operating temperature of the catalyst material), the output voltage being derived from the network in such a way that its value is dependent on the value of the current supplied to the network; with this arrangement changes in the resistance of the sensing element resistor that would otherwise occur due to the thermal effects to be sensed are counteracted by changes in the current supplied to the network, which are in turn reflected in changes in the output voltage. This type of "constant temperature" arrangement has long been known in principle, but appears to have found little practical application in gas detection systems of the kind specified. In particular there seems to have been no appreciation hitherto of the advantages that may be gained from the use of a constant temperature arrangement in respect of the factors discussed above. As to the first of these, it has been found possible when using a constant temperature arrangement to achieve much lower values of the heating-up time required to reach a steady operating condition with a given type of sensing element than is the case when using a standard Wheatstone bridge arrangement. As to the second factor, it has been found possible when using a constant temperature arrangement to dispense with any need for a compensating element similar to the sensing element, by providing a simple form of compensation for variations of ambient temperature, the constant temperature arrangement itself being inherently adapted to compensate for variations of supply voltage.

According to one aspect of the invention, there is provided a gas detection system of the kind specified in which said thermally sensitive resistor is connected in a resistive bridge network arranged to be supplied with current whose value is set by a control means which can assume either a first state such that sufficient current is supplied to the network to cause the sensing element of the system to be heated to an elevated operating temperature or a second state such that the network is substantially de-energised, the control means being operative in said first state so that the system has a steady state condition in which the value of the current is automatically controlled by the control means, in

response to a feedback signal derived from the network, so as to maintain the resistance of said resistor substantially constant, the system comprising means for causing the control means to change from said second state to said first state and to revert to said second state after a period during which the system will reach said steady state condition, means for deriving from the network an output voltage whose value when the system is in said steady state condition is dependent on the value of the current supplied to the network, and means for obtaining a measurement by virtue of the sampling of said output voltage during the part of said period when the system is in said steady state condition.

According to another aspect of the invention, there is provided a gas detection system of the kind specified in which said thermally sensitive resistor is connected in a resistive bridge network arranged to be supplied with sufficient current to cause the sensing element of the system to be heated to an elevated operating temperature, the system comprising a control means which is operative so that the system has a steady state condition in which the value of the current is automatically controlled by the control means, in response to a feedback signal derived from the network, so as to maintain the resistance of said resistor substantially constant, means for deriving from the network an output voltage whose value when the system is in said steady state condition is dependent on the value of the current supplied to the network and hence is subject to unwanted variation as a result of changes in the temperature of the surroundings of the sensing element, and means for obtaining a measurement by virtue of the comparison of said output voltage with a reference voltage derived from a circuit which includes a semiconductor diode disposed so as to be exposed to the temperature of said surroundings, the diode having a temperature coefficient such that said unwanted variation in respect of said output voltage is compensated for by corresponding variation in the reference voltage.

One gas detection system in accordance with the invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a part sectional view of a sensing head forming part of the system;

Figure 2 is a diagram of a pellistor operating circuit incorporated in the system;

Figure 3 is an explanatory diagram;

Figure 4 is a diagram of a reference circuit incorporated in the system; and

Figure 5 is a block diagram illustrating the overall electrical arrangement of the system.

The system to be described is intended for the detection of methane in air at concentrations up to 5%, and is designed to enable measurements of methane concentration to be made on an intermittent basis, either at the will of an operator (as would be appropriate in a portable instrument for making spot tests) or at regular intervals under automatic control (as would be appropriate in an instrument for "continuous" monitoring).

Referring to Figure 1, the system includes a sensing head incorporating a metal block 1 through which extends a cylindrical passage 2 communicating with inlet and outlet pipes 3 and 4. Formed in the block 1 is a cylindrical cavity 5 which extends from the top of the block 1 to meet the passage 2; the inner end of the cavity 5 is covered by part of a tubular member 6 of metal gauze which fits closely within the passage 2. Within the cavity 5 is disposed a pellistor 7 (Type VQ3), the ends of the wire which constitutes the thermally sensitive resistor of the pellistor 7 being respectively attached to support wires 8 and 9 which form part of a header of a type commonly used in semiconductor devices; the header is held in place by a cap 10 so as to cover the outer end of the cavity 5. Also formed in the block 1 is a cavity 11 within which is disposed a silicon diode 12 (Type BAX13) arranged in good thermal contact with the metal of the block 1. In operation of the system a stream of gas drawn from an atmosphere to be monitored is pumped through the passage 2, and gas from this stream diffuses through the member 6 into the cavity 5 so as to reach the pellistor 7; with the pellistor 7 at an appropriate temperature (suitably in the range 550 - 600°C), the presence of methane in the gas reaching it will give rise to a heating effect on the pellistor 7 due to the combustion of methane brought about by the catalyst material. The pumping may be either continuous or intermittent, as appropriate to the particular type of instrument involved; in the latter case it is of course necessary before a measurement is made to allow a suitable delay from the start of pumping on each occasion, to take account of the time taken for gas to reach the pellistor 7 from the atmosphere to be monitored.

Figure 2 shows the operating circuit for the pellistor 7, which is arranged to be energised by a battery 13 connectable between positive and negative supply terminals 14 and 15 by means of a switch 16. The voltage of the battery 13 is nominally 10 volts, but drops to about 8 volts as the battery 13 discharges in use. The pellistor 7 has its resistor 17 connected so as to form one arm AB of a bridge network ABCD, the other arms BC, CD and DA of which are respectively constituted by a resistor 18 (3.9 ohms), a resistor 19 (1 kilohm) and a resistor 20 (1 kilohm). The point A is connected to the terminal 15 and the point C is connected to the emitter of an N-P-N transistor 21 (Type 2N3055), whose collector is connected via a wirewound resistor 22 (4.7 ohms) to the terminal 14.

In order to control the current supplied to the network ABCD from the battery 13 via the transistor 21, there is provided a servo loop comprising a differential operational amplifier 23 (Type CA3130) and a P-N-P transistor 24 (Type BFY70), the inverting and non-inverting input terminals of the amplifier 23 being respectively connected to the point D and B, the output terminal of the amplifier 23 being connected to the base of the transistor 24 via a resistor 25 (10 kilohms) and a resistor 26 (1 kilohm) in series, the emitter of the transistor 24 being connected directly to the terminal 14, the base of the transistor 24 being connected to the terminal 14 via a resistor 27 (15 kilohms), and the collector of the transistor 24

being connected to the base and emitter of the transistor 21 respectively via a resistor 28 (51 ohms) and a resistor 29 (10 kiloms). The supply terminals of the amplifier 23 are respectively connected to the terminals 14 and 15, and the input offset adjustment terminals of the amplifier 23 have connected between them a potentiometer 30 (100 kilohms) whose tapping point is connected to the terminal 15. The amplifier 23 also has a control terminal, connected to an input line X, by means of which the amplifier 23 may be switched between its normal active state and a quiescent state, the former applying when the control terminal is left floating and the latter applying when it is connected to the terminal 15. Capacitors 31 and 32 (both 330 picofarads) are respectively connected between the output terminal and the inverting input terminal of the amplifier 23 and between the control terminal and one of the input offset adjustment terminals of the amplifier 23, in order to suppress any tendency for high frequency oscillations to occur.

The circuit also includes a P-N-P transistor 34 (Type BFY72) having its emitter connected to the terminal 14, its collector connected to the junction between the resistors 25 and 26, and its base connected via a resistor 35 (4.7 kilohms) to the junction between resistors 36 and 37 (respectively 120 ohms and 560 ohms) which are connected in series across the resistor 22; as explained further below, the function of this part of the circuit is to limit the current supplied to the network ABCD in a starting condition in which the pellistor 7 is being heated up to its desired operating temperature. A capacitor 38 (0.1 microfarads) connected between the base of the transistor 34 and the terminal 14 serves a similar purpose to the capacitors 31 and 32. Finally, the circuit includes a potentiometer 39 (10 kilohms) connected between the points A and C and having its tapping connected to an output line Y.

Considering now the operation of the circuit shown in Figure 2, when the amplifier 23 is held in the quiescent state its output is switched off and the transistor 21 is accordingly maintained in a high impedance state; the network ABCD is then substantially de-energised, so that the pellistor 7 is virtually unheated. When the amplifier 23 is in the active stage, a substantial current is supplied to the network ABCD via the transistor 21 so that the pellistor 7 is heated to the required operating temperature. In this case the steady state condition of the system is such that, with the amplifier 23 working in a linear mode, the servo loop operates to vary the current supplied to the network ABCD, in response to the voltage appearing between the points B and D, so as to maintain the resistance of the resistor 17 at a substantially constant value corresponding to the required operating temperature of the pellistor 7. The potentiometer 30 which constitutes the input offset control of the amplifier 23 is set so that in equilibrium the point B is held approximately 1 millivolt positive with respect to the point D, i.e. the controlled value of the resistor 17 is slightly greater than 3.9 ohms; this arrangement is preferable from the point of view of stability to one involving precise balance of the network ABCD in equilibrium. The operating temperature of the pellistor 7 is thus effectively determined by the values of the resistors 18, 19 and 20, and it is therefore important that these values should not be significantly influenced by the value of the current supplied to the network ABCD; in particular, since the bulk of this current flows through the resistor 18 as well as the resistor 17, it is appropriate for the resistor 18 to be wound from wire having a low temperature coefficient of resistivity and to be made physically large enough to ensure that its temperature in operation is not greatly above ambient temperature. It should be noted that in the steady state condition the operation of the servo loop is substantially independent of the voltage of the battery 13 over the possible range of values of this voltage, and that in this condition the transistor 34 has no significant function since it is maintained in a high impedance state.

It will be appreciated that with the pellistor 7 maintained at a constant temperature there is a balance between the rate at which heat is lost from the pellistor 7 to its surroundings and the sum of the rates at which heat is absorbed by the pellistor 7 respectively as a result of the passage of current through the resistor 17 and as a result of any combustion of methane occurring on the catalyst material. It will thus be seen that, for a given rate of heat loss, in the steady state condition the value of the current supplied to the network ABCD (and hence the value of the voltage appearing between the points A and C) varies inversely with the concentration of methane in the gas in the cavity 5; the variation is substantially linear over the range of concentrations which the system is designed to measure. With the circuit components as quoted above the value of the voltage appearing between the points A and C in the steady state condition falls at the rate of approximately 100 millivolts for one per cent increase in methane concentration; for zero methane concentrtion the value of this voltage is approximately 2.4 volts when the block 1 is at a temperature of 20°C. The value of the voltage appearing between the points A and C in the steady state condition is utilised to provide a measure of methane concentration; how this is done, in a way providing a zero reference and temperature compensation, is described in detail below.

It is, however, appropriate first to consider the operation of the circuit shown in Figure 2 in the starting condition which occurs when the amplifier 23 is switched from the quiescent state to the activity state. In this condition a substantial out-of-balance voltage rapidly appears between the points B and D (the resistance of the resistor 17 when unheated being about 1.3 ohms), so that the amplifier 23 is driven into a saturated condition. Accordingly the impedance of the transistor 21 is substantially lower, and the current supplied to the network ABCD is substantially higher, than is the case for the steady state condition. This state of affairs holds until the pellistor 7 has virtually reached the required operating temperature, since the control range of the servo loop corresponds to a relatively narrow range of values of the resistance of the resistor 17; the

pellistor 7 is thus heated up rapidly without any asymptotic approach to the operating temperature such as is encountered when using a standard Wheatstone bridge arrangement. During this phase, as the resistance of the resistor 17 increases, the voltage between the points A and C increases substantially linearly with time to reach a value above that which it has in the steady state condition; at the end of this phase the servo loop comes into its normal mode of operation and brings the system into the steady state condition with a slight further delay (associated with thermal lag in the refractory material of the pellistor 7) of somewhat less than 0.2 seconds. In the absence of countermeasures, the length of the initial heating-up phase would vary with changes in the voltage of the battery 13, which would give rise to changes in the current supplied to the network ABCD in this phase. Such an effect is substantially eliminated by the action of the transistor 34, which is operative in this phase to vary the input to the transistor 24 in such a way as to prevent the voltage appearing across the resistor 22 significantly exceeding the value which it has when the voltage of the battery 13 is at its minimum value. With this arrangement, the length of the initial heating-up phase is held substantially constant at approximately 0.7 seconds so that a total time of less than 0.9 seconds is required for the system to reach the steady state condition after the amplifier 23 is switched from the quiescent state to the active state. The process is illustrated in Figure 3, which shows the variation of the voltage (V) appearing between the points A and C with the time (T) elapsed from the switching of the amplifier 23; the solid and broken curves at the right hand side respectively relate to cases in which methane is absent from and present in the gas in the cavity 5.

Returning now to the question of obtaining a measure of the methane concentration, in respect of which one need consider only the steady state condition, it will be apparent from what is said above that changes in the rate of loss of heat from the pellistor 7 will give rise to changes in the value of the voltage appearing between the points A and C for a given methane concentration. The principal factor which may cause changes in the rate of heat loss is the temperature of the block 1. Over the range of values 0 - 40°C for this temperature it is found that the variation of the voltage for a given methane concentration is practically linear with a coefficient of approximately −1.6 millivolt/°C; the total change of voltage if the temperature varies over this range is thus equivalent to a change of more than 0.6% in methane concentration. If reliable measurements of methane concentration are to be obtained therefore, it is necessary either to maintain the temperature of the block 1 substantially constant (which would normally be impractical for an instrument for field use) or to provide compensation for the effects of variation of this temperature.

The output voltage developed by the pellistor operating circuit shown in Figure 2 (i.e. the voltage appearing between the line Y and the terminal 15) is of course directly proportional to the voltage appearing between the points A and C, and its coefficient of variation with the temperature of the block 1 is likewise proportionately lower. Since the output voltage has a non-zero value for zero methane concentration it is appropriate (in order to obtain a signal suitable for operating an indicating device) to offset it with a reference voltage having a value equal to the value of the output voltage for zero methane concentration. It is then possible to provide temperature compensation by arranging for the reference voltage to vary in a similar manner to the output voltage with changes in the temperature of the block 1. Figure 4 shows a circuit by means of which such a reference voltage is generated. The circuit comprises a resistor 40 (4 kilohms) and a reference device 41 (Type ZN458) which has a negligible temperature coefficient, connected in series between the terminals 14 and 15; connected across the device 41 is the series combination of a potentiometer 42 (5 kilohms), whose tapping is connected to an output line Z, and the silicon diode 12 (see Figure 1). With this arrangement the voltage appearing across the combination of the components 42 and 12 is held substantially constant at 2.5 volts, regardless of changes in the voltage of the battery 13 and the ambient temperature; the voltage appearing across the diode 12 varies with the temperature of the block 1, the value for a temperature of 20°C being 0.7 volts and the temperature coefficient being approximately −2 millivolts/°C over the range 0 − 40°C. The reference voltage generated by the circuit (i.e. the voltage appearing between the line Z and the terminal 15) can thus be chosen, by the setting of the potentiometer 42, to have any value between 0.7 to 2.5 volts when the temperature of the block 1 is 20°C; if the chosen value is denoted by V_R volts, the coefficient of variation of the reference voltage with the temperature of the block 1 is approximately equal to $-2(2.5 - V_R)/1.8$ millivolts/°C. On the other hand the corresponding coefficient for the output voltage of the pellistor operating circuit is approximately equal to $-1.6\, V_o/2.4$ millivolts/°C, where V_o volts is the value of the output voltage for zero methane concentration when the temperature of the block 1 is 20°C. Obviously, the potentiometers 39 and 42 must be set so that $V_R = V_o$, but this can be satisfied for any value between 0.7 and 2.4. It is therefore possible to impose an additional condition on the potentiometer settings such that the temperature coefficients of the output and reference voltages are made equal; from the expressions quoted above it can readily be seen that when both conditions are met V_o and V_R will be approximately 25/16. Precise matching can of course be achieved by setting the potentiometers 39 and 42 empirically for a specific system, but it will normally be possible to achieve a sufficient degree of temperature compensation by choosing the settings in accordance with assumed typical values for the temperature coefficients of the diode 12 and the voltage appearing between the points A and C; when using such values, it would of course also be possible to replace the potentiometers 39 and 42 by appropriately proportioned potential dividers constituted by fixed resistors. It will be appreciated that, with the potentiometers 39 and 42 set as described

above, the difference between the output and reference voltages will be a voltage whose magnitude is directly proportional to methane concentration, substantially unaffected by changes in the temperature of the block 1 over the range 0 - 40°C.

It should be noted that the rate of loss of heat from the pellistor 7 is also liable to be affected by changes in the thermal conductivity of the gas in the cavity 5, but the magnitude of any error due to this cause is normally within an acceptable tolerance for accuracy of the measurement of methane concentration. The most significant factor affecting the thermal conductivity is likely to be the relative humidity of the atmosphere being monitored; it is therefore normally appropriate to base the calibration of the system (in respect of the precise value of the voltage appearing between the points A and C which is taken to correspond to zero methane concentration) on air with a relative humidity of 50%.

Figure 5 illustrates the overall electrical arrangement of the system, with the circuits shown in Figures 2 and 4 respectively constituting the components designated 43 and 44. Each measurement operation is initiated by a pulse derived from a pulse generator 45. In an instrument for "continuous" monitoring, the generator 45 is free running so as to generate a regularly recurrent train of pulses, suitably with a repetition period of 10 seconds or more; in a portable instrument for making spot tests, the generator 45 is operable manually to generate a single pulse whenever a measurement is required. The output of the generator 45 is applied to the set terminal of a bistable latch 46 and to the input of a delay circuit 47 designed to give a delay of 0.9 seconds. The latch 46 controls the operation of a switching circuit 48, which in its closed state connects the line X of the circuit 43 to the terminal 15 to hold the amplifier 23 in the quiescent state; operation of the latch 46 by the pulse from the generator 45 opens the switching circuit 48 and thus switches the amplifier 23 into the active state. The circuit 43 then operates as described above, with the steady state condition being reached before the delayed pulse appears at the output of the circuit 47. The output of this circuit is applied to trigger a further pulse generator 49, which generates a first pulse of duration 0.1 seconds and a second pulse immediately following the first. The first pulse from the generator 49 is utilised to operate a sample-and-hold circuit 50 connected to the output of the circuit 43, so as to obtain the value of the output voltage required for the measurement; between successive operations of the generator 49, the output of the circuit 50 of course remains substantially constant at the last sampled value. The second pulse from the generator 49 is applied to the rest terminal of the latch 46, causing the switching circuit 48 to close so that the amplifier 23 reverts to the quiescent state. It will thus be seen that for each measurement operation a significant current is drawn from the battery 13 for only 1 second. The outputs of the sample-and-hold circuit 50 and the reference circuit 44 are applied to a subtraction circuit 51, the output of which provides a signal indicative of methane concentration, this signal can of course be used for indication or control purposes either locally or at a remote station. In a portable instrument the circuit 51 may suitably be replaced by a digital voltmeter incorporated in the instrument and arranged to respond to the difference between the outputs of the circuits 50 and 44.

In some cases a requirement may arise for a gas detection system of the kind specified by means of which there can be made two different types of measurement requiring the use of significantly different operating temperatures for a catalytic sensing element. The system described above with reference to the drawings can readily be modified to meet such a requirement without any need for duplication of the pellistor operating circuit. A suitable arrangement would involve the provision of a means for automatically switching the resistance in the arm BC of the bridge network so that the resistance is maintained at lower and higher values respectively during first and second phases of each measurement operation, and the addition of a second sample-and-hold circuit connected to the output of the pellistor operating circuit; the arrangement would of couse be such that during the first phase one sample-and-hold circuit is operated after the system has reached a steady state condition with the pellistor at the lower of the two operating temperatures, and that during the second phase the other sample-and-hold circuit is operated after the pellistor has been further heated up and the system has reached another steady state condition with the pellistor at the higher operating temperature. The outputs of the two sample-and-hold circuits could then be utilised, either singly or in an appropriate combination, to provide measurement signals; in a portable instrument it would be convenient to provide a single meter to which the measurement signals could be selectively applied at the choice of the operator.

CLAIMS

1. A gas detection system of the kind specified, in which said thermally sensitive resistor is connected in a resistive bridge network arranged to be supplied with current whose value is set by a control means which can assume either a first state such that sufficient current is supplied to the network to cause the sensing element of the system to be heated to an elevated operating temperature or a second state such that the network is substantially de-energised, the control means being operative in said first state so that the system has a steady state condition in which the value of the current is automatically controlled by the control means, in response to a feedback signal derived from the network, so as to maintain the resistance of said resistor substantially constant, the system comprising means for causing the control means to change from said second state to said first state and to revert to said second state after a period during which the system will reach a steady state condition, means for deriving from the network an output voltage whose value when the system is in said steady state condition is dependent on the value of the current supplied to the network, and means for obtaining a measurement by virtue of

the sampling of said output voltage during the part of said period when the system is in said steady state condition.

2. A gas detection system according to Claim 1, in which said means for obtaining a measurement includes means for comparing the sampled value of said output voltage with referencwe voltage derived from a circuit which includes a semiconductor diode disposed so as to be exposed to the temperature of the surroundings of the sensing element, the diode having a temperature coefficient such that unwanted variation of the value of said output voltage when the system is in said steady state condition, resulting from changes in the temperature of said surroundings, is compensated for by corresponding variation in the reference voltage.

3. A gas detection system of the kind specified, in which said thermally sensitive resistor is connected in a resistive bridge network arranged to be supplied with sufficient current to cause the sensing element of the system to be heated to an elevated operating temperature, the system comprising a control means which is operative so that the system has a steady state condition in which the value of the current is automatically controlled by the control means, in response to a feedback signal derived from the network, so as to maintain the resistance of said resistor substantially constant, means for deriving from the network an output voltage whose value when the system is in said steady state condition is dependent on the value of the current supplied to the network and hence is subject to unwanted variation as a result of changes in the temperature of the surroundings of the sensing element, and means for obtaining a measurement by virtue of the comparison of said output voltage with a reference voltage derived from a circuit which includes a semiconductor diode disposed so as to be exposed to the temperature of said surroundings, the diode having a temperature coefficient such that said unwanted variation in respect of said output voltage is compensated for by corresponding variation in the reference voltage.

4. A gas detection system of the kind specified, substantially as hereinbefore described with reference to the accompanying drawings.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1982.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.